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1 542 602

(54) CONTACTING DEVICE FOR AN ELECTRICAL CONNECTOR

(71) We, MULTILAM CORPORATION, a corporation organized and existing under the laws of the State of California, United States of America, of 985, Fremont Avenue, Los Altos, Ca. 94022, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to electrical connectors and contacting devices therefor.

In U.K. Patent Specification No. 1,125,830 there is described and claimed a socket for an electrical plug-and-socket connector consisting of a socket body with a hole in which are disposed contact elements constituted by one or more strips of sheet metal having at least one row of contact ridges formed by twisting relative to a plane or surface of the strip the material between a series of parallel slits made in the strip. While this arrangement is satisfactory in certain connector applications it has limitations in as much as it requires trade-offs between structural characteristics and electrically conducting characteristics. Thus, while one material may be a good electrical conductor, it may not have the proper structural characteristics, including resilience, and vice versa. Limitations such as this provide relatively little freedom in selecting materials for forming louvered connectors of the type described in the above patent specification. If better conducting materials could be employed, a vastly better design could be achieved. A need, therefore, has arisen to provide a more suitable electrical connector, one providing greater latitude in selecting materials for use in various applications having different structural and electrical requirements.

According to the present invention an elongate contacting device for an electrical connector has a pair of end pieces and a plurality of slats extending therebetween, the slats each having a pair of spaced apart side margins and a central portion inclined to the plane defined by the end pieces and means disposed on the surface of each slat to form an electrically conductive path between the side margins thereof.

The present invention also includes an electrical connector having such a contacting device. The slats can be formed of one material and the electrical conducting portion can be of a second material thereby allowing greater selectively of material characteristics and thereby greater latitude in meeting structural, electrical conduction and other requirements.

The invention enables production of electrical conductors of various sizes, configurations and current-carrying capacities using a standard size contacting device. Thus, the invention can be made in the form of an assembly of contacting devices arranged in side-by-side relationship to fit and to form an electrical path between a pair of flat bus-bars or plates. Alternatively, the assembly of contacting devices can be cylindrical in shape to fit along the inner surface of an electrically conducting sleeve for receiving a jack or plug. The slats can be integral with side strips or individual slats can be mounted one-by-one in end bars or strips. The slats can be of electrically conductive material or non-conductive material, the only requirement being that the additional means on the surface of each slat is electrically conducting to form the current-carrying path across the transverse dimension of the slat.

Thus, the invention is able to provide an improved electrical connector of the louvered type wherein each slat has a layer of electrically conducting material clad thereon in any suitable manner so that the resulting product can have optimum structural and electrically conductive characteristics notwithstanding the fact that the materials of the slat and the clad layer differ from each other. Because of better conductivity, larger and wider slats can be used which, in turn, creates a much broader design range and important economies in connector design.

The connector can be formed from one or more louvered contacting devices and the slat portions thereof can be either electrically non-conducting or conducting depending upon the design requirements to be met, the

resulting product having excellent current-carrying capabilties and adaptability to various electrical members to be interconnected.

Several examples of contacting devices and connectors according to the invention will now be described with references to the accompanying drawings, in which:—

Fig. 1 is a slat of a louvered contacting device which is clad with an electrically conducting means across the central portion thereof;

Fig. 1*a* is a fragmentary view similar to Fig. 1, but showing the edge portion of the conducting means in the form of fingers;

Fig. 1*b* is a cross-sectional view taken along line 1*b*—1*b* of Fig. 1;

Fig. 1*c* is a view similar to Fig. 1*b* but showing another example of slat;

Fig. 2 is a view of one group of slats arranged in an assembly for use as part of the contacting device of an electical connector;

Fig. 3 is a fragmentary, perspective view showing two contacting devices substantially the same as in Fig. 2, disposed between a pair of flat, electrically conducting plates defining a bus bar connector;

Fig. 4 is a view of a device similar to that of Fig. 2 except that each slat acts individually and separately as a connector circuit;

Fig. 5 is a side view of the assembly of Fig. 4;

Fig. 6 is a perspective view of a tubular connector showing another embodiment of a group of slats arranged within a cylindrical member;

Fib. 7 is an elevational view of a louvered contacting device having slats integral with a pair of side strips, with the layer of electrically conductive material being of greater conductivity, than the base material of the slats per se;

Fig. 8 shows another slat showing an electrically conducting material clad thereto;

Fig. 9 is a side view of an assembly of slats as shown in Figure 8 showing the layer material passing through slots to allow the material to pass from one face of each slat to the opposite face thereof;

Fig. 10 is a side view of a slat showing another way in which the layer material can be applied to each slat;

Fig. 11 is a view similar to Fig. 9 illustrating a contacting device with a non-conductive edge holder;

Fig. 12 is a perspective view of a slat in a support having slots parallel to the plane of the slat to eliminate the need for twisting the ends of the slat; and

Fig. 13 is a side view of the assembly of Fig. 12.

The present invention, in its basic form, comprises slat 12 provided with arcuate, curved side edges 14 and 16 and integral with end extensions 18 and 20 which are generally coplanar with each other. The plane of the slat 12 is angled with respect to extensions 18 and 20 as shown in Fig. 1*b* and the slat has curved outer margins 22 which are out of the plane of the major portion 24 thereof. The material of the slat 12 can be of metal, plastics or the like and the material is preferably of the type providing a mechanical springing action which allows the slat 12 to twist about an axis through extensions 18 and 20 when force is applied to outer margins 22 thereof, such as when the slat is between a pair of connector members as hereinafter described.

The slat 12 is clad with a layer 26 of electrically conducting material and this layer can be applied in the form of an overlapping or wrap-around strip, an inlay strip, or as a plated surface or as a sputtered or other type of surface. The material of layer 26 extends from one outer margin 22 to the opposite outer margin 22 of the slat 12 so that, when the slat is between a pair of electrically conducting members, the clad layer 26 will form an electrically conducting bridge between the members. Thus, the slat 12 need not be electrically conductive and may be of plastics or other electrically non-conductive material or a metal of relatively low conductivity but high strength. The conducting path will, of cource, be through layer 26 and it generally will be adequate for most purpones without the need to make the slat 12 from an electrically conducting material. It is also possible to apply conductive layers 26 to both sides of the slat 12 where the latter is of a metallic material in the same manner to create the same effect as in the form of an overlying wrap-around layer 26.

Fig. 1*c* shows how layers 26 can be disposed on opposite sides of the slat.

The foregoing construction also allows for the use of the best material for the mechanical spring action of the slat 12 and at the same time the most suitable electrically conductive material for the conductive path. Also, in combination with the most desirable material for the slat 12, the clad layer can also be selected for desired properties and economies. Moreover, the clad material can be of sufficient thinness to allow for it to be clad in an arcuate curve along the slat 12 and about the side margins 22 thereof as shown in Fig. 1*b*. This assures proper electrical contact at all times with conducting members utilized with the device.

The method of fastening the clad layer can include any one of a number of different techniques including crimping, welding, brazing, folding through slots in the slat or by adhesive bonding. Individual slats can then be attached to edge holding devices to form contacting devices 10, by similar mechanical techniques, including molding of plas-

tics or ceramic materials around the extensions 18 and 20 of each slat 12. Inlaying of the material can also be used. Individual slats formed with conductive layers can be assembled in edge holding devices in any desired fashion including tight side-by-side spacing. This vastly improves current density per unit length of this assembly. Figs. 12 and 13 show slats 12 whose ends are in the same plane as that of the slat itself, i.e., the ends are not twisted. The ends drop into slots 15 of mounting members 17, the slots being parallel to the plane of the slat.

The slats can be used individually in assemblies of different configurations. One such assembly is shown in Fig. 2, wherein a plurality of contacting devices 10 having slats with clad layers 26 are arranged side-by-side with each other and have the ends of their extensions 18 and 20 secured to respective bars 27 and 29 in any suitable manner. The thickness of each bar is selected so that the side margins of clad layers 26 of devices 10 can make electrical contact with bus bars or plates 31 and 33 as in the Fig. 3 embodiment on opposed sides of the assembly. The plates are electrically conductive and are held in fixed, spaced positions by mechanical means (not shown). In such positions, they bear against the curved side portions of clad layers 26 as shown in Fig. 1*b* and the slats 12 are slightly sprung so that they bias their respective layers 26 into firm, positive electrical contact with adjacent surfaces of plates 31 and 33. Also, bars 27 and 29 limit the amount of flexing which the slats 12 can be subjected to since the bars serve as spacers to prevent movement of plates 31 and 33 beyond a certain minimum distance.

Fig. 3 also shows how a group of assemblies of the same general type shown in Fig. 2 can be combined to form a large bank of clad contacting devices. For instance, additional bar or bars 35 are provided so that additional slats can be coupled to and extend between bars 29 and 35.

Fig. 1*a* shows a slat 12 provided with a clad layer 26 provided with fingers 37 formed by slits extending from the side margins of layer 26 toward the central region thereof. Fingers 37 can flex independently of each other so that they can be automatically adjustable for any surface irregularities on bus bars 31 and 33. The number of slits and their lengths are selected for particular design requirements.

Another assembly of contacting devices 10 is shown in Fig. 4, wherein the devices are arranged generally parallel with each other and have the ends of their extensions 18 and 20 secured in place in any suitable manner so that the clad layers 26 of devices 10 make electrical contact with respective electrically conducting strips 30. For instance, each extension 18 can be brazed to an end segment 28 of strip 30, while the opposite extension 20 can be embedded or otherwise bonded to a rail 32 integral with a panel or board 34 on which strips 30 are mounted. A second rail 36 of panel 34 abuts segments 28 and the latter can have a lateral projection 37 overlying one face of rail 36 and secured thereto such as by screws, adhesive or other fastening means. The opposite end of each strip 30 is provided with another segment 38 provided with a sharp V-groove 40 therein for special purposes, such as electrically connecting each strip and thereby its corresponding device 10 with a special type of connecting member.

A plurality of devices 10 can be carried in a cylindrical tube or housing as shown in Fig. 6 and thereby can be used to form a socket for a plug-in connector. In the specific application shown in Fig. 6, an electrically conductive sleeve 46 has an open end 48 for receiving an assembly of cylindrical contacting devices 10 the slats of which span the distance between a pair of rings 50, only one of which is shown in Fig. 6. Means (not shown) can be, if desired, added to the assembly to provide plug-gripping holding teeth to allow a plug to be inserted into the open end of connector 46 but such a plug, once in contact with the holding teeth, can not be easily removed.

As shown in Fig. 6, each slat is clad with an electrically conducting material layer 26 as described above with respect to Fig. 1. When a plug is inserted into the open end 48, the plug will cause the slats 12 to compress in a manner such that they will be biased both against the inner surface of sleeve 46 and against the plug, whereby the clad layers 26 will bridge the distance therebetween to provide an electrically conducting path therefor.

This same principle can be utilized where the slats are in a radial pattern layout as in a washer shape. In such case, the slats will surround a central axis of will be provided with concentric inner and outer rings.

The spring member can be either metal, plastics, ceramic or similar materials. The mechanical and thermal properties of the spring member are separate and distinct from the characteristics of the conductive material overlay. In a preferred design, the mechanical spring would be a high grade spring material, such as stainless steel, formed into a single slat. The overlay or clad layer could be of electrical grade copper sheet or film which is plated or unplated and attached to the central part of the spring member.

Edge holding members, such as bars 27 and 29 for extensions 18 and 20, hold the individual slats in desired patterns and the holding members also function as a deflection limiting means for each slat. By selecting the thickness of the edge holding member, the

amount of slat deflection can be accurately controlled.

The slats, connected to non-conductive edge holding devices can function as individual circuit connectors or as multiple contacts for higher currents greater than that usable with an individual slat. For example, one slat may have a maximum current-carrying capacity of 10 amperes. It may transfer this specific current as an independent contact device. If ten such slats are formed in an assembly such as the assembly of Fig. 2, they are able to work together to transfer a much larger current since the current is distributed through the slats. Thus, if one slat 10 can handle 10 amperes, ten such devices can handle 100 amperes.

Clad slats as described above with respect to this invention can be fabricated not only from various combinations of materials to combine the best properties for a particular application, but can be of various sizes in both length and width. Wide slats employing highly conductive metals offer a distinct advantage in numerous applications for which wide mechanical tolerances are required. For example, if the conductive overlay is silver, the conductive capacity would be at its optimum for most applications. This means that the conductiveness across the slats is as great as through the material they connect. Slats can then be as large as necessary without sacrificing the electrical or thermal properties as would be necessary if hardened beryllium copper only were used to form the slat rather than the aforesaid material combination. The width of these slats can be used to allow for much larger mechanical tolerance between mating surfaces in all applications. Thus, if 200 amp bus bars were to be connected with a multiplicity of slats, such as in Fig. 3, for example twenty slats capable of handling 10 amps each would be used.

Another use for clad slats would be to incorporate the above slat assembly inside a standard size piece of copper or conductive metal pipe and allowing for the slat assembly to contact the inner surface of this pipe. For connecting purposes, another smaller size but standard electrically conductive rod could be inserted into the first pipe, thereby creating an inexepensive pin and socket assembly, eliminating machining and other costs.

Other embodiments of the present invention include assembly 110 (Fig. 7), wherein a plurality of slats 112 which are integral at their opposed ends with strips 114 and 116 are side-by-side relative to each other. The strips at each edge of the slats are generally coplanar with each other when assembly 110 is in a flattened condition. Each of strips 114 and 116 has spaced edge-wise teeth 118 which can be bent to provide spacers or standoff means as desired or needed.

Each of the slats 112 is clad with a layer 120 of electrically conducting material, layers 120 being at the central portions of devices 122 and being applied thereto in any one of the ways described above with respect to slats 12. Moreover, each slat 112 may have a pair of opposed, convex, curved outer margins as in the embodiments shown in Figs. 10 and 11.

The material forming slats 112 and strips 114 and 116 can be electrically non-conducting or electrically conducting, as desired or necessary, and the clad layers can be applied thereto generally after formation of the slats. Fig. 10 shows an enlarged end elevational view of one of the slats 112 showing one form of the outer margins of the device. Fig. 11 shows a group of similar slats with another form of outer margin.

Figs. 8 and 9 show still another embodiment of slat denoted by the numeral 212. A plurality of such slats are shown in Fig. 9 and, each comprising a pair of opposed, generally coplanar strips 214 used in the manner shown in connection with strips 114 and 116 in Fig. 7 to join slats 212 in an integral fashion.

Each slat 212 has a pair of spaced slits 216 therein for receiving a clad layer 218. Thus, the layer commences at one curved outer margin of the slat, then upwardly and over, and down along one face of the slat, then through the first slit 216, then along the opposite face of the slat to the next slit 216, then through the slit and along the first-mentioned face and about the opposite outer margin 222. In this way, layer 218 is properly supported along both faces of the slat and is in the proper orientation at the outer margins 220 and 222 to provide an electrical current path between members in engagement with the layer at or adjacent to such outer margins 220 and 222.

WHAT WE CLAIM IS:—

1. An elongate contacting device for an electrical connector, the device having a pair of end pieces and a plurality of slats extending therebetween, the slats each having a pair of spaced apart side margins and a central portion inclined to the plane defined by the end pieces; and means disposed on the surface of each slat to form an electrically conductive path between the side margins thereof.

2. A contacting device according to claim 1, wherein means forming an electrically conductive path comprises a layer of electrically conductive material.

3. A contacting device according to claim 2, wherein each layer of conductive material has a number of flexible fingers adjacent each side margin of the slat.

4. A contacting device according to any

one of claims 1 to 3, wherein each slat is integral with the end pieces of the device and is disposed at an angle with respect thereto, the device being formed at least partly from a resilient material to allow the slats to yield when disposed between and in proximity to a pair of spaced-apart electrical conductors.

5. A contacting device according to any one of claims 2 to 4, wherein the layer of electrically conductive material extends along and contiguous to one of the faces of the slat.

6. A contacting device according to any one of claims 2 to 5, wherein each electrically conductive layer is spaced from the end pieces of the device.

7. A contacting device according to any one of claims 1 to 6, wherein the end pieces of the device are flat and generally coplanar with each other.

8. A contacting device according to any one of claims 2 to 7, wherein each electrically conductive layer has side portions extending around edges of the slat adjacent the side margins of the faces of the slat.

9. A contacting device according to claim 8, wherein the side margins of each slat are out of the plane of the major portion of the slat, each side portion of the layer extending from one face of the slat, around the edge thereof, and then partially along the opposite face of the slat.

10. A contacting device according to any one of claims 1 to 9, wherein each slat is fromed from an electrically non-conductive material.

11. A contacting device according to any one of claims 1 to 9, wherein each slat is formed from a material different from the material of the respective conductive path.

12. A contacting device according to any one of claims 1 to 11 wherein the end pieces comprise a pair of spaced-apart bars, the ends of the slats being secured to respective bars.

13. A contacting device according to any one of claims 1 to 11, wherein the end pieces comprise a pair of spaced-apart rings, the end of the slats being coupled to respective rings.

14. A contacting device according to any one of claims 1 to 11, wherein the end pieces comprise a pair of spaced-apart strips with which the slats are integrally formed.

15. A contacting device according to claim 12, wherein each bar has a plurality of spaced slots therein for receiving the ends of respective slats.

16. A contacting device according to 1, substantially as described with reference to any one of the examples shown in the accompanying drawings.

17. An electrical connector which includes one or more contacting devices according to any one of claims 1 to 16.

18. An electrical connector according to claim 17, which includes a plurality of contacting devices, and means mounting the contacting devices in an assembly with the devices in side-by-side relationship.

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1542602 COMPLETE SPECIFICATION

6 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

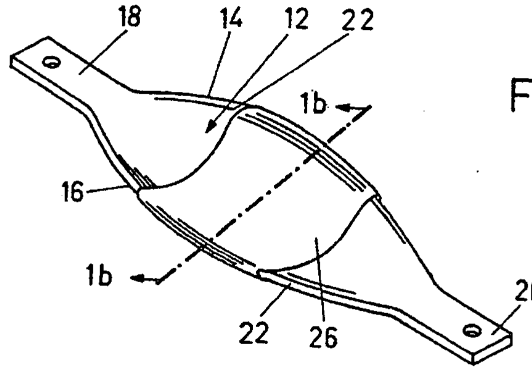

FIG.1

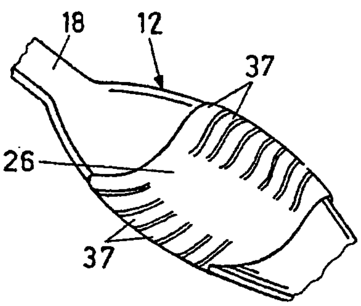

FIG.1a

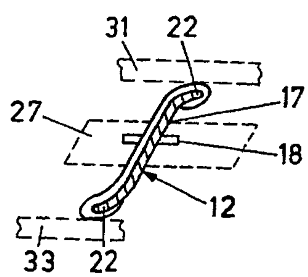

FIG.1b

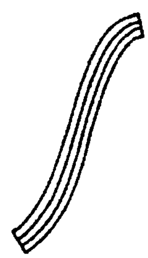

FIG.1c

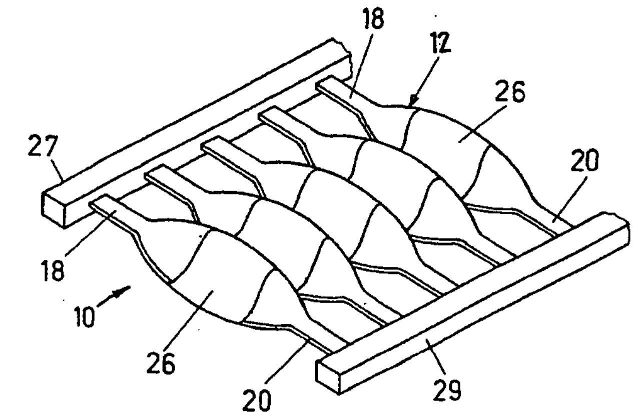

FIG. 2

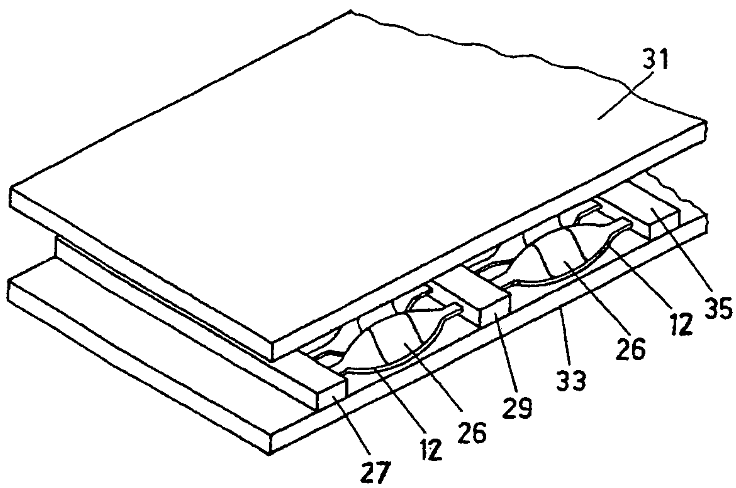

FIG. 3

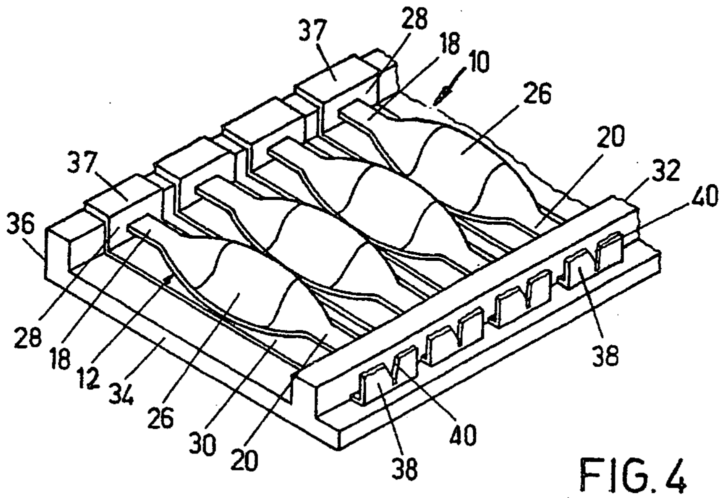

FIG. 4

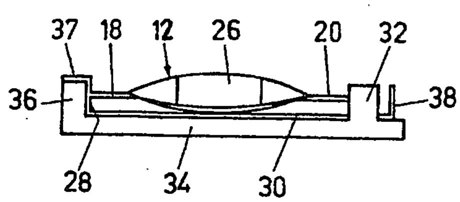

FIG.5

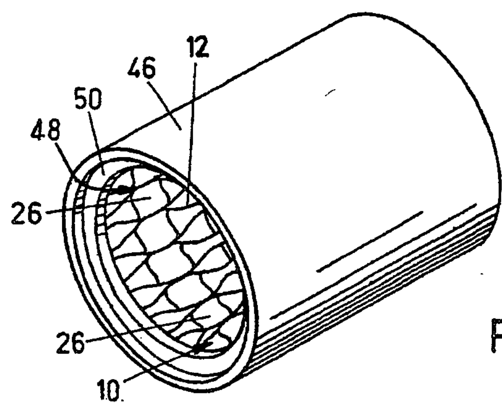

FIG. 6

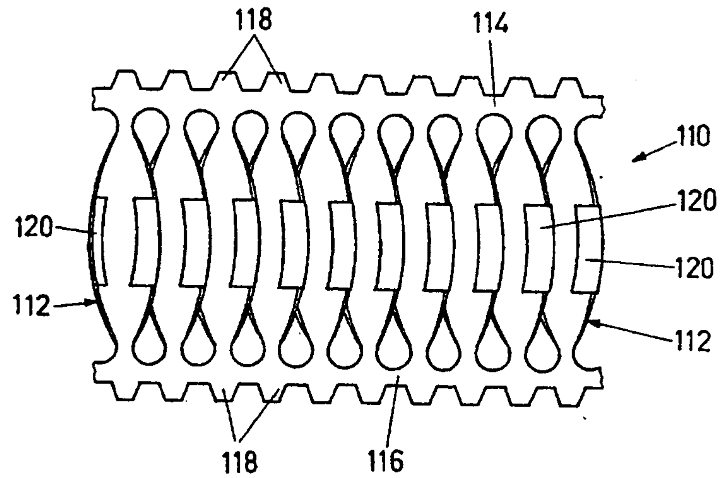

FIG.7

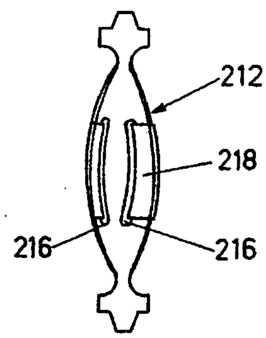

FIG.8

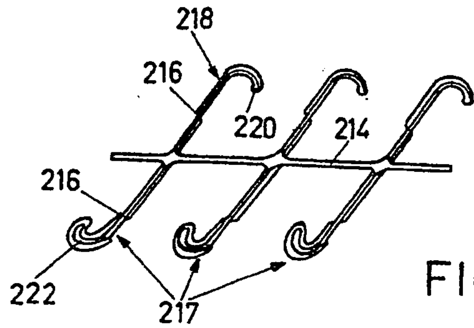

FIG.9

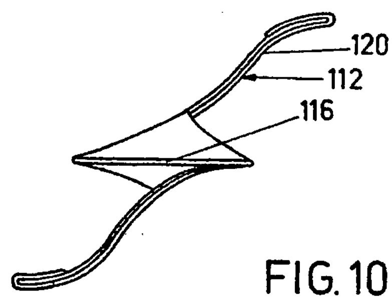

FIG.10

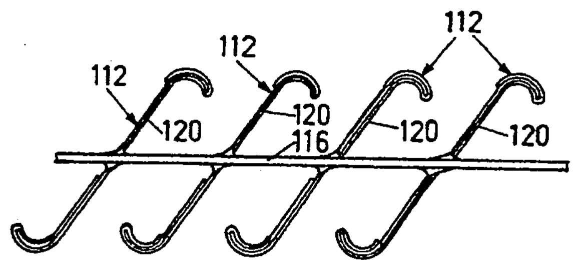

FIG.11

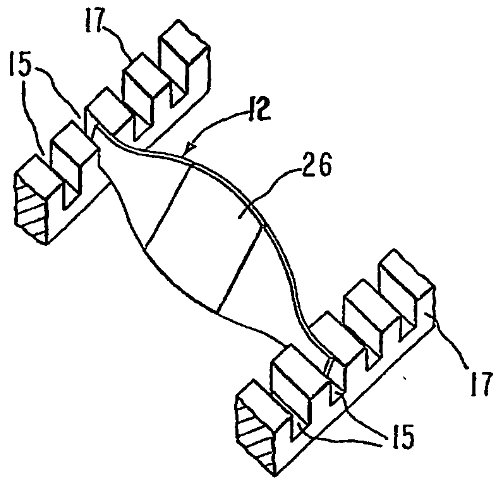

FIG.12

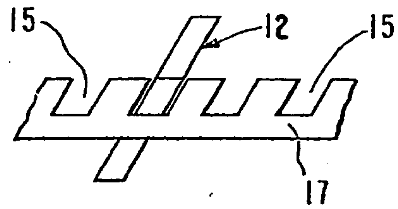

FIG.13

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